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Variation of the grain compositions in the ash from the 2011 eruption of Shinmoedake, Kirishima volcano, Japan: insights into the conduit processes

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We determined the grain and chemical compositions of the tephra emitted from the 2011 eruption series of Shinmoedake, Kirishima volcano. The main eruption types that have been recorded are sub-plinian and vulcanian eruptions. As the main result, we found that the products from both eruption types, sub-plinian and vulcanian, have similar grain and chemical compositions.
Shinmoedake, one of the eruptive centers of Kirishima volcanoes located in southern Kyushu, Japan, repeated eruptions from January to September 2011. The eruption series started by a phreato-magmatic explosion in January 19, followed by sub-plinian eruptions on January 26-27, extrusion of lava that filled the summit crater, vulcanian eruptions since the end of January, and minor ash emissions. We collected on-site ash samples derived from all types of eruptions during each event. This provides a rare chance to investigate the characteristics of the eruptive products through time and the possible correlations with the eruption style.
We observed color, shape, and vesicularity of the grains in the range 0.25-0.50 mm in diameter, using the optical stereoscopic microscope and SEM. Juvenile materials, with fresh morphology, are classified into five types of grains based on their vesicularity and color: P (light-colored pumice), S (dark-colored scoria), WG (white glassy dense block), GG (gray glassy dense block), and BG (black glassy dense block). For each eruption, we counted the number of grains of each type among an original population of 200 grains (referred hereafter to as 'ash sample'). The five types of grains are found in every ash sample analyzed from all types of eruptions, although the proportion is variable. The proportion of highly-vesicular grains (sum of P and S types) increased from 14% (phreato-magmatic explosion of January 19) to 26.5% (sub-plinian eruption of January 26), and then decreased and fluctuated between 2-25.5% (vulcanian eruptions from February to August).
The groundmass of the juvenile grains of all eruption types has a narrow range of chemical compositions that lie around 65 wt% SiO_2, despite the variation in color, shape, and vesicularity of the grains.
We conclude that the constituents and chemical compositions of the different grains are similar, despite of the great variability in the eruptive style (sub-plinian vs vulcanian), and thus eruption intensity. This means that even vulcanian eruptions were caused by ascent of fresh magma, and not sourced by magma lying beneath the crater. The large variation (2-25.5%) of the proportion of highly-vesicular grains for the vulcanian eruptions may be caused by minor changes of the magma ascent rate in the conduit.